

**REMARKS**

Claims 1-88 are all the claims pending in the application.

At the outset, acknowledgment of Applicants' claim for foreign priority under 35 U.S.C. § 119, has not yet been made. Accordingly, Applicants request confirmation of receipt of certified copies of the priority documents filed on April 5, 1999.

Also, the Examiner has not forwarded initialed copies of the Form PTO-1449 filed with Applicants' IDS on December 10, 1999, and the IDS filed on August 2, 2000, to indicate that the listed documents have been considered and made of record. Accordingly, Applicants request that these documents be considered and that the initialed Form 1449 forms be forwarded.

Claims 76, 82, and 87 are amended.

Claim 76 has been amended to recite that the range for the OH group bound to Ti applies to the titanium oxide carrier prior to forming the catalyst. Support for this amendment can be found on page 49, first full paragraph, of the specification.

Claim 76 has been further amended to recite that the range for the OH group bound to Ti is  $3 \times 10^{-4}$  to  $10 \times 10^{-4}$  mol per one gram of the titanium oxide carrier. Support for this range can be found in original claims 82 and 87.

Claims 82 and 87 have been amended to recite a lower limit for the range for the OH group bound to Ti, which is  $3.3 \times 10^{-4}$ . Support for this amendment can be found at Example 11 of the specification.

Claim 81 is cancelled.

Entry of the above amendments is respectfully requested.

**I. Claim rejections under 35 U.S.C. § 112**

Claims 76, 79, 81-85, 87 are rejected under 35 U.S.C. 112, second paragraph, as purportedly being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

**A. The Examiner's position**

It is unclear to the Examiner if the claimed amount of OH group is the amount bound to the titanium dioxide carrier before it is used to form the catalyst, or whether it is the amount bound to the titanium dioxide carrier after it is used to form the catalyst.

**B. Response**

Independent claim 76 has been amended to recite that the claimed range for the OH group refers to the titanium oxide carrier prior to forming the catalyst.

In view of the above, Applicants respectfully request that the rejection under 35 U.S.C. §112 be withdrawn.

**II. Claim rejections under 35 U.S.C. § 103(a)**

Claims 76, 79, 81-85, 87 are rejected under 35 U.S.C. 103(a) as being unpatentable over Grätzel '231, optionally in view of Bankmann et al (5,387,726) or Umemura et al (4,177,161). Also, these claims are rejected as purportedly being unpatentable over Buysch et al (6,001,768), optionally in view either of Bankmann or Umemura.

Applicants respectfully traverse these rejections for the following reasons.

Claim 76 recites a supported ruthenium oxide catalyst having not less than 80% by weight of rutile titanium oxide and wherein prior to forming said catalyst the titanium oxide carrier contains an OH group bound to Ti in an amount of  $3 \times 10^{-4}$  to  $10 \times 10^{-4}$  mol per one gram of the titanium oxide carrier.

Applicants have recognized that the combination of the claimed rutile titanium oxide and the claimed concentration of OH groups in the titanium oxide carrier has a surprising result on the dispersity of ruthenium oxide on the surface of the titanium oxide and on the activity of the catalyst.

Applicants showed the former benefit in the second Declaration under 37 C.F.R. § 1.132 by Seki. For example, the catalyst of Experiment 1 of the second Declaration, in which the crystal structure of the titanium oxide was rutile, did not exhibit coagulated particles of ruthenium oxide, whereas the anatase structure and the structure having 17% rutile/83% anatase

exhibited coagulated particles (see Photos 1-3). The presence of coagulated particles means that the supported ruthenium oxide cannot be highly dispersed.

Applicants submit herewith a graph illustrating the dependency of activity of the catalyst on amount of OH group in the titanium oxide carrier. The data points correspond to Examples 5, 14, 15, and 17 of the specification, and they illustrate that the activity of the catalyst is unexpectedly superior when the amount of OH group is within claimed range. For example, Example 15 of the specification illustrates the improved catalyst activity. The catalyst of Example 15 included the same rutile titanium oxide of Experiment 1 of the second Declaration, and had a content of OH groups of about  $6 \times 10^{-4}$  mol per one gram of the titanium oxide carrier, which is within the claimed range. As stated on page 189 of the specification, the activity of the catalyst was  $7.85 \times 10^{-4}$  mol/min·g-catalyst.

Gratzel, on the other hand, fails to recognize the problem of coagulated ruthenium oxide particles and fails to teach or suggest Applicants' claimed solution therefore. Quite to the contrary, Gratzel suggests that anatase and rutile structures are equally good when used in conjunction with the taught mixed ruthenium (column 3, lines 26-31). Furthermore, Gratzel teaches production of titanium oxide by oxidizing  $\text{TiCl}_4$  at high temperature in a gas phase (aerosil method), and the amount of OH group on the surface of the titanium oxide is as small as  $2.8 \times 10^{-4}$  mol/g-carrier.

Buysch et al teaches a catalyst in which a platinum metal compound is supported on a metal oxide selected from many metal oxides. Buysch et al fails to teach an example in which ruthenium oxide is supported on a specific titanium oxide carrier. Furthermore, the calcination conditions taught by Buysch (100-800°C and 0.5-50 hours) is very broad, and includes those for which a rutile titanium oxide can be converted to an anatase structure. Thus, like Gratzel, Buysch fails to teach or suggest the problems associated with structures, such as the anatase structure, that are not within the claimed structure for the carrier. Buysch also fails to teach or suggest the dependency of the catalytic activity on the amount of OH groups or the superior results that flow from the claimed range therefore.

Amendment under 37 C.F.R. § 1.111  
USSN 09/249,100

Umemura et al and Bankmann et al fail to correct the deficiencies of Gratzel and Buysch. Neither reference teaches or suggests the claimed ranges for the rutile structure and the content of OH groups of the titanium oxide carrier. Furthermore, the cited references fail to provide the motivation to combine them in the manner necessary to meet the claims. For example, Gratzel teaches methane synthesis from hydrogen and carbon dioxide, whereas Umemura et al relates to the synthesis of maleic anhydride by oxidation of an unsaturated hydrocarbon, and Bankmann et al teaches hydrogenation of carbonyl groups in aromatic aldehydes. Rather, Applicants respectfully submit that the Examiner has relied upon impermissible hindsight to combine the cited references.

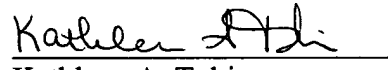
In conclusion, the cited references fail to anticipate or render obvious Applicants' claimed invention.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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**APPENDIX**  
**VERSION WITH MARKINGS TO SHOW CHANGES MADE**

**IN THE CLAIMS:**

**Claim 81 is canceled.**

**The claims are amended as follows:**

76. (Thrice Amended) A supported ruthenium oxide catalyst obtained by supporting on a titanium oxide carrier containing not less than 80 % by weight of rutile titanium oxide, wherein prior to forming said catalyst the titanium oxide carrier contains an OH group bound to Ti in an amount of  $[0.1 \times 10^{-4} \text{ to } 30 \times 10^{-4}]$   $3 \times 10^{-4} \text{ to } 10 \times 10^{-4}$  mol per one gram of the titanium oxide carrier.

82. (Thrice amended) The catalyst according to claim 76, wherein the titanium oxide carrier contains an OH group bound to Ti in an amount of  $[3 \times 10^{-4}]$   $3.3 \times 10^{-4}$  to  $10 \times 10^{-4}$  mol per one gram of the titanium oxide carrier.

87. (Twice Amended) The catalyst according to claim 79, wherein the titanium oxide carrier contains an OH group bound to Ti in an amount of  $[3 \times 10^{-4}]$   $3.3 \times 10^{-4}$  to  $10 \times 10^{-4}$  mole per one gram of the titanium oxide carrier.

# *Dependency of Activity on Amount of OH Group*

